EEEP3201

DIGITAL CONTROL SYSTEMS: TUTORIALS (2019/2020)

Exercise 1

(a) Draw a block diagram representing a Digital control system.
(b) Differentiate between a differential equation and a difference equation

(c) State and explain some advantages of digital control systems

Exercise 2

Find the Z-transform and the ROC of a signal given as x(n) = {7,3,4,9,5}, where origin of the series is at 3.

Exercise 3

Compute the z-transform of the functions $x_1[n] = \delta[n-2]$ and $x_2[n] = \delta[n+2]$.

Exercise 4

Find the response of the system: $s(n+2) - 3s(n+1)+2s(n) = \delta(n)$, when all the initial conditions are zero

Exercise 5

Find the system function H(z) and unit sample response h(n) of the system whose difference equation is described as : $y(n)=1/2*y(n-1)+2x(n)$ where, y(n) and x(n) are the output and input of the system, respectively.

Exercise 6

Determine Y (z), n ≥ 0 in the following case $-y(n) + 1/2\, y(n-1) - 1/4\, y(n-2) = 0$
Given: $y(-1) = y(-2) = 1$

Exercise 7

Compute the inverse z-transform of the function: $F(z) = z^{-2} + z^{-1} + 1/0.2z^{-2} + 0.9z^{-1} + 1$ using (a) the partial fraction expansion and

Exercise 8

Compute the inverse z-transform of the following:

$$F_1(z) = \frac{10z}{(z-1)(z-0.5)}, \quad F_2(z) = \frac{2z^3 + z}{(z-2)^2(z-1)}$$

Exercise 8

Find the transfer function of the following discrete systems:

a. $y(k)+0.5y(k-1)=2x(k)$

b. $y(k)+2y(k-1)-y(k-2)=2x(k)-x(k-1)+2x(k-2)$

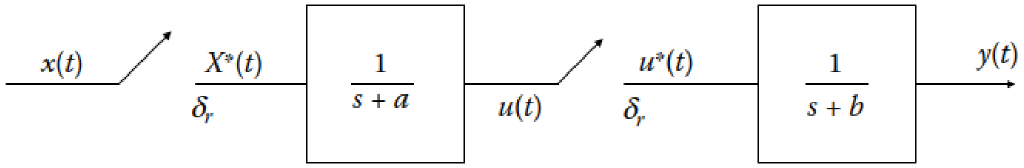
Exercise 9

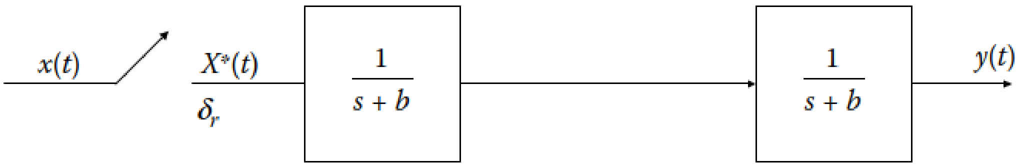
Derive the difference equations of the systems with transfer functions:

$$G(z)=\frac{z^4+3z^3+2z^2+z+1}{z^4+4z^3+5z^2+3z+2} \quad \text{and} \quad H(z)=\frac{z}{z^2-1.7z+0.72}$$

Exercise 10

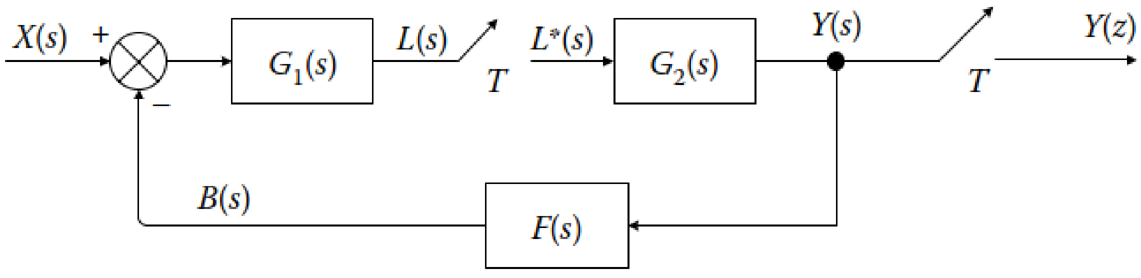
Derive the transfer function of the following discrete systems and show that they are different to each other.





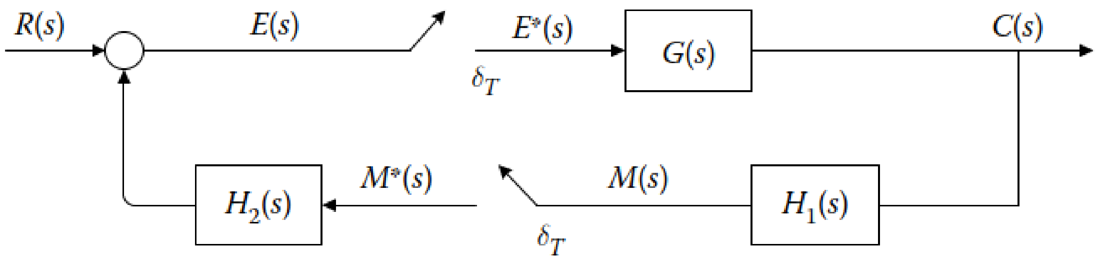
Exercise 11

Find the expression that provides the output $Y(z)$ as a function of the input and the included system parameters, as shown in the following scheme:



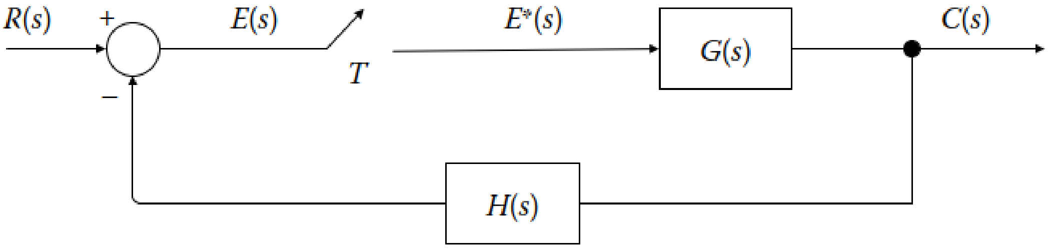
Exercise 12

For the system of the following scheme, find the closed-loop transfer function $C(z)/R(z)$



Exercise 13

For the system of the following scheme, find the closed-loop transfer function $C(z)/R(z)$, using Mason's formula.



Exercise 14

Consider a system with transfer function $G(s) = (1/s + \alpha)$. Find the discrete transfer function $G(z)$ using the invariant impulse response method.

Exercise 15

Find the digital filter resulting from the conversion of the first-order analog low-pass filter $G(s) = (1/s + 1)$, using (a) the exponential method and (b) the FOH method.

Exercise 16

Convert the analog controller $G(s) = (4/(s+4))$ into a digital form using the Tustin method.

Exercise 17

Convert the analog filter with transfer function $G(s)=((s+0.1)/((s+0.1)^2+9))$ into a digital filter using the invariant impulse method.

Exercise 18

The characteristic polynomial of a system is $\alpha(z) = z^3 - 1.3z^2 - 0.8z + 1$. Evaluate the system stability using the Jury stability criterion.

Exercise 19

Derive the region of values for K, such that the closed system shown in the following scheme is stable (a) using the Routh criterion and (b) using the Jury criterion.

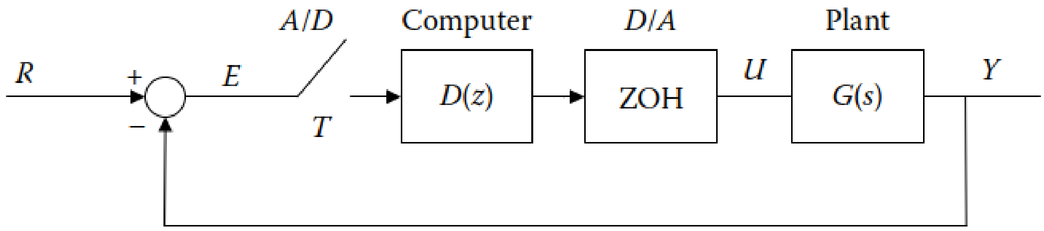
Exercise 20

For the system of the following scheme with $G(s) = 1/s(s+1)$:

a. Derive the transfer function of the digital controller $D(z)$ when the desired transfer function of the closed system is

$$G_{cl}(z) = \frac{z+1}{z^2 - 1.14z + 0.403}$$

b. Derive and design the discrete-time response $y(kT)$ of the closed system when the input is a unit step signal.



Let: $T = 0.1$ s.

Exercise 21

For the system of the following scheme with $G(s) = e^{-2s}/(1+0.5s)$ and $T = 0.5$ s

a. Derive the digital PI controller using the pole cancellation technique. Define the controller gain so as to satisfy that the cut-off frequency of the open-loop system is approximately 0.2.

b. Provide the transfer function and the difference equation of the controller.

c. Define the first 15 values of the step response of the closed system.